

Chapter 22 Heat Transfer

# Exercises

## 22.1 Conduction (pages 431–432)

1. Define conduction.

the transfer of energy within materials and between different materials that are in direct contact

2. What is a conductor?

A conductor is a material that conducts heat well.

3. Metals are the best conductors.

4. In conduction, collisions between particles transfer thermal energy.

5. Is the following sentence true or false? Conduction occurs without any overall transfer of matter. true

6. Is the following sentence true or false? Materials that are good conductors of heat are usually poor conductors of electricity.  
false

7. Imagine stepping with one bare foot onto metal and with the other bare foot onto wood. Explain why the metal feels cool and the wood feels warm, even though they have the same temperature.

Metal is a good conductor, but wood is a poor conductor. Heat easily moves out of your foot into the cooler metal. Little heat moves out of your foot into the wood, so your foot does not sense that it is touching something cooler.

8. Define insulator.

any material that is a poor conductor of heat and that delays the transfer of heat

9. How do birds vary their insulation?

by fluffing their feathers to create air spaces

10. Classify each of the following materials by writing *C* beside each conductor and *I* beside each insulator.

I a. wood

C g. iron

C b. aluminum

I h. wool

I c. straw

I i. paper

C d. silver

C j. copper

I e. air

I k. polystyrene

I f. cork

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11. Explain why snow is sometimes used to construct dwellings in cold climates.

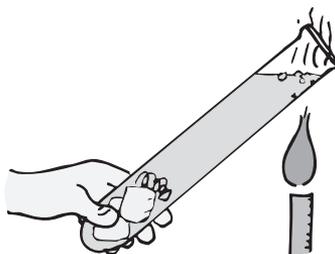
**Snowflakes imprison a lot of air in their crystals and are good insulators. The snow prevents heat from escaping too rapidly.**

12. Is the following sentence true or false? Both heat and cold are forms of energy. **false**

13. Is the following sentence true or false? An insulator cannot totally prevent heat from getting through, but instead just reduces the rate at which heat penetrates. **true**

### 22.2 Convection (pages 433–435)

14. In convection, heat is transferred by movement of the **hotter** substance from one place to another.



15. The figure above shows ice at the bottom of a test tube and boiling water at the top. Explain why the heat that boils the water doesn't melt the ice.

**The hot water at the top of the tube is less dense and floats. Any heat that reaches the ice must be transferred by conduction, but water is a poor conductor of heat.**

16. Suppose a heater is placed near the floor of a room. Describe the steps in which convection currents keep the air stirred up in the room.

**The heater warms nearby air, and the warm air rises. Cooler air near the ceiling moves downward, and the heater warms it. This air then rises, and the process continues.**

17. Convection currents stirring the atmosphere produce **winds**.

18. Explain the two ways convection currents produced by uneven heating of Earth's surface produce sea breezes.

a. During the day:

**The shore warms more easily than the water. Air over the shore rises, and cooler air from above the water takes its place, producing a breeze toward the land.**

b. At night:

**The shore cools off more quickly than the water. Air over the water rises, and cooler air from above the shore takes its place, producing a breeze toward the sea.**

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19. Is the following sentence true or false? As air rises, it expands because more atmospheric pressure squeezes on it at higher altitudes.  
\_\_\_\_\_ **false** \_\_\_\_\_
20. When a molecule collides with a molecule that is receding, its rebound speed after the collision is \_\_\_\_\_ **less** \_\_\_\_\_ than it was before the collision.
21. Is the following sentence true or false? As air rises and expands, it collides with more molecules that are receding than are approaching.  
\_\_\_\_\_ **true** \_\_\_\_\_
22. In expanding air, the average speed of the molecules \_\_\_\_\_ **decreases** \_\_\_\_\_, and the air cools.

**22.3 Radiation (page 436)**

23. Why can't energy move from the sun to Earth by conduction or convection?  
**Conduction is the transfer of heat from molecule to molecule, and convection is the transfer of heat by expansion and rising of matter. Both of these are impossible in space because there is almost no matter.**
24. Radiation is energy transmitted by **electromagnetic waves**.
25. Define radiant energy. **energy that is transmitted by radiation**
26. Order the different types of radiant energy from longest to shortest wavelength by placing a number from 1 to 7 beside each.
- |          |                       |          |                          |
|----------|-----------------------|----------|--------------------------|
| <u>7</u> | a. gamma rays         | <u>5</u> | e. ultraviolet radiation |
| <u>3</u> | b. infrared radiation | <u>4</u> | f. visible light         |
| <u>2</u> | c. microwaves         | <u>6</u> | g. X-rays                |
| <u>1</u> | d. radio waves        |          |                          |
27. Circle the letter of the type of radiant energy you feel as heat if you sit near a fireplace.
- |  |               |
|--|---------------|
| <input checked="" type="radio"/> a. infrared radiation | b. microwaves |
| c. ultraviolet radiation                               | d. X-rays     |

**22.4 Emission of Radiant Energy (pages 437–438)**

28. Is the following sentence true or false? All substances continuously emit only one specific wavelength of radiant energy. \_\_\_\_\_ **false** \_\_\_\_\_
29. Do objects at low temperatures emit waves with a longer or shorter wavelength than objects with higher temperatures? \_\_\_\_\_ **longer** \_\_\_\_\_
30. Objects of everyday temperatures emit waves mostly in the \_\_\_\_\_ **long-wavelength** \_\_\_\_\_ end of the infrared region.
31. An infrared thermometer measures the infrared radiant energy emitted by a body and converts it to \_\_\_\_\_ **temperature** \_\_\_\_\_.
32. The average \_\_\_\_\_ **frequency** \_\_\_\_\_ of radiant energy is directly proportional to the Kelvin temperature of the emitter.

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33. Order the star colors white, red, and blue from coolest to hottest.

red, white, blue

34. The radiant energy emitted by stars is called stellar radiation.

35. The radiant energy emitted by Earth is called terrestrial radiation.

36. The part of radiant energy that is absorbed by objects increases the internal energy of the objects.

**22.5 Absorption of Radiant Energy (pages 438–440)**

37. An object in thermal equilibrium is both absorbing and radiating energy at the same rate.

38. The temperature of an object doesn't change if it is in thermal equilibrium.

39. Good emitters of radiant energy are also good absorbers.

40. You notice that a blacktop pavement becomes hotter than other nearby surfaces on a hot day. What will you notice about the temperature of the blacktop pavement at night?

It will cool faster than other surfaces.

41. A good absorber of radiant energy appears dark.

42. Suppose you have a box, painted white inside, which is closed except for a hole 2 centimeters wide. Circle the letter beside the sentence that explains why the hole appears black.

a. The white paint inside the box absorbs almost all of the radiant energy that strikes it.

b. The hole in the box is much too small to allow wavelengths of light to pass through.

c. Light that enters is reflected and partly absorbed so many times that little is left to come out.

d. The light that enters leaks out through the walls of the box.

43. Is the following sentence true or false? Light-colored objects reflect more light than dark-colored ones. true

44. On a sunny day, Earth's surface is a net absorber, and at night it is a net emitter.

45. Record-breaking cold nights occur when the skies are clear.

**22.6 Newton's Law of Cooling (pages 440–441)**

46. An object hotter than its surroundings eventually cools to match the surrounding temperature.

47. A hot apple pie will cool faster in a freezer than on a kitchen table because the temperature difference is greater.

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48. State Newton's law of cooling.

The rate of cooling of an object is approximately proportional to the temperature difference between the object and its surroundings.

49. Is the following sentence true or false? Newton's law of cooling also holds for heating. true

### 22.7 Global Warming and the Greenhouse Effect (pages 441–443)

50. What is the greenhouse effect?

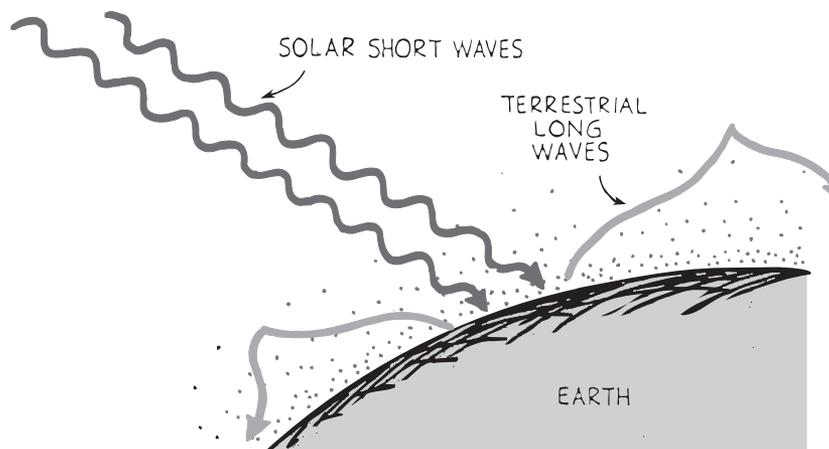
the warming of a planet's surface due to the trapping of radiation by the planet's atmosphere

51. Air is transparent to both infrared (long) waves and visible (short) waves, unless the air contains excess carbon dioxide and water vapor.

52. Glass is transparent to visible light waves, but absorbs infrared waves.

53. Explain why the inside of a car becomes so much hotter than its surroundings on a hot day.

Short wavelengths from the sun can pass through the car's glass and into the car, warming the car. The car radiates longer wavelengths that cannot pass out through the glass. The energy is trapped inside the car.



54. Use the figure above to explain Earth's global warming.

Earth's atmosphere allows short waves from the sun to pass through. These waves strike Earth, which re-radiates the energy as longer waves. Atmospheric gases absorb and re-emit much of this long-wavelength radiation back to Earth.

55. Water vapor is the main greenhouse gas.

56. CO<sub>2</sub> is the gas most rapidly increasing in the atmosphere.